THE ARNOLD ARBORETUM DURING THE FISCAL YEAR ENDED JUNE 30, 1938

THERE were no radical changes in the financial situation, the endowment and the income therefrom remaining the same as at the end of the preceding year. From voluntary gifts and in response to a much more limited appeal to the friends and supporters of the Arboretum than the one sent out in the early part of 1937, our extra-budgetary gift fund for current expenditure was increased by about $6100. Supplementing this unrestricted amount, about $8560 was received for restricted purposes. Of the latter $6500 was provided to help meet the cost of printing the Bibliography of Eastern Asiatic Botany, made up of a grant of $2000 from the Harvard-Yenching Institute, $500 from the Smithsonian Institution, and $4000 from an anonymous donor. Other restricted gifts include $500 for the construction of a lath house in which to exhibit the Larz Anderson collection of dwarf Japanese trees, $500 for the care of conifers, $500 for lichen research, and $125 for special photographic equipment. Three payments from the American Philosophical Society, amounting to $562.50, represent three-fourths of a grant of $750 to the director to cover a part of the cost of the revision of the Bornean species of *Eugenia*. Dr. Raup has received a grant of $1500 from the Milton Fund of Harvard University which will be utilized for financing field work in Northwestern Canada in the summer of 1939. The Arboretum is grateful to its friends and supporters for their continued interest, as the contributions, large and small, enable its staff to amplify the work of the institution and to undertake important improvements that could not be financed from its regular income.

Buildings and Grounds. — No major expenditures were needed to maintain the permanent buildings of the Arboretum. All of these are now in excellent condition, although the Administration building is now badly crowded because of the constant and steady increase of the library and reference collections. The grounds have been maintained in their usual attractive condition, and the usual program of pruning, spraying, thinning, transplanting and fertilizing has been continued. It is only by constant attention to these details that the existing plantings can be maintained and improved. The winter season was not a severe one and there was little loss from winter killing. We enjoy the full cooperation

of the City authorities in the fulfillment of the City's duty to the Arboretum through the Park, Police, and Fire Departments.

The outstanding accomplishment of the year has been the practical completion of the field work on a detailed map of the entire Arboretum area. Several earlier maps had been prepared and partly completed, but all of them were out of date. In addition to accomplishing the necessary field surveys Dr. Croizat, taking advantage of rainy days, has completed the drawing of 60 maps of which about 20 had been field checked before the close of the fiscal year. For this purpose the entire Arboretum area, approximately 265 acres, was divided into 74 compartments, each 400 x 600 ft. On each compartment map the exact position of each planted tree and shrub is shown; and on these master maps the name of each plant will be indicated. Supplementing these compartment maps 26 additional ones, on a larger scale, have been prepared to show the exact position of shrubs in crowded plantings. Once completed, this series of detail maps will be kept up to date, and as plants are removed, or new ones placed in permanent positions, the detail maps will reflect these changes. This is the first time that a detailed planting map has been prepared to cover the entire Arboretum area, and after its completion in 1938–39 it will be infinitely useful for a variety of purposes. The chief work that remains to be done is the verification and checking of the binomial plant names, and with this objective in view, Mr. Palmer has devoted two seasons' work to the task of preparing many thousands of herbarium specimens, to be checked on the accession records, in the herbarium, and in the library.

Horticulture. — The horticultural and landscape features of the Arboretum are among its greatest assets. Consistently developed in a masterful manner through many years, every effort must be devoted to the preservation and amplification of those features that have most materially helped in making the institution the outstanding one of its kind. During the year 2762 living plants, cuttings of 72 species, and 315 packets of seeds have been received; of the living plants received, 1830 came from various sources in the United States, 734 from England, 110 from Russia, 60 from the Netherlands, 50 from France and 11 from Germany. In the same period 1404 packets of seeds have been sent to fill requests from various parts of the United States and fifteen foreign countries. Supplementing this seed distribution, 1671 plants and 611 cuttings were distributed, mostly to individuals and institutions in the United States and Canada, but some in England, the Netherlands and Germany. Over 400 plants, many new to the permanent collections,

were removed from the nursery and placed in their permanent positions in the grounds. A temporary nursery to take care of about 500 plants received from American nurserymen was established on the Bussey Institution grounds, and a new, more extensive piece of land is being prepared for a permanent nursery on the Walter Street tract.

Mr. Judd was authorized to spend about two months in Great Britain and in Europe for the purpose of locating in public and private institutions desirable additional woody plants for the Arboretum collections. As a result of his summer's work the Arboretum received, in the early spring, shipments from England and the Continent containing about 373 species of woody plants, imported under a special permit granted by the Federal Horticultural Board, all being new to the Arboretum collections.

An extensive poison ivy eradication campaign was initiated with a view of reducing the number of these undesirable plants within the entire Arboretum tract, and this will be continued until the objective is attained. The old willows along the Arborway, decrepit with age, and dangerous because of falling branches, received attention during the winter months when about one-third of them were removed. Others will be taken out later until the last of them are gone. Replacement plantings of red maple and sour gum are being made. The entire juniper collection, badly damaged in the severe winter of 1933–34, was renovated and a part of it rearranged. Large plantings on Bussey Hill, the cherries and plums near the Forest Hills entrance, and considerable parts of the lilac, *Philadelphus*, *Viburnum*, and crabapple collections have been extensively fertilized in furtherance of our general plan of improving existing plantings by supplying the elements essential to good plant growth.

Close contacts have been maintained with Dr. Sax and his assistants in the extensive hybridization work that has been carried on during the spring and summer season. The practical objective here is to originate new ornamental forms, emphasizing the potential possibilities of this or that species or variety as one of the parents. In such work it is highly important that careful attention be given to the horticultural characters of the plants used for making crosses. To amplify the propagating program and to make it more efficient, two electric hotbeds were installed in the greenhouses, where investigations are constantly being made with woody plants known to be difficult to root from cuttings. Considerable progress has been made and the program will be continued during the coming year.

A notable acquisition in the late fall was the famous Larz Anderson

collection of dwarf Japanese trees. This unique collection, including plants at least 200 years old, was delivered to the Arboretum in the fall of 1937 by Mrs. Anderson, a gift of the late Mr. Larz Anderson as a memorial to his friend Charles Sprague Sargent. The plants were stored in our pit during the winter, and in the spring were placed on display in a specially designed lath house which had been constructed during the winter. This construction was made possible through a generous donation from Mrs. Anderson. This gives the Arnold Arboretum the only extensive collection of these unique plants in any public institution in America. (See: The Larz Anderson collection of Japanese Dwarf Trees, Arnold Arb. Bull. Pop. Inf. IV. **6**: 31–39. 1938.)

Associated with the horticultural work is a certain amount of publicity through the daily press, through lectures, and through the preparation of special articles for various magazines. About 50 illustrated lectures on the Arboretum and its work were delivered by Dr. Wyman, involving trips to points as far away as Washington, Detroit, Cleveland, Ann Arbor and Grand Rapids. In the spring an unusually large number of garden club members visited the Arboretum to inspect the plantings under guidance of staff members. Somewhat over 2000 letters in answer to inquiries regarding ornamental plants were prepared and dispatched. In natural color photography about 250 Leica slides and approximately 2400 feet of film were prepared.

Much attention has been devoted to the Bulletin of Popular Information, the usual number having been prepared and issued during the year. The mailing list now approximates 1600, and the demand for the publication is increasing, clearly indicating that it fills a distinct need.

Supplementing the regular work of the Arboretum, Dr. Wyman and Professor Rehder have devoted considerable time and energy in cooperating with the American Joint Committee on Horticultural Nomenclature in revising Standardized Plant Names. This involved an actual examination of over 1200 nursery catalogues from all over the world, as well as many standard reference works and accredited manuals. The net result is the addition of approximately 40,000 new names to this reference work. The Arboretum does not sponsor Standardized Plant Names, but as a part of its service to horticulture, made the resources of the institution available to the committee charged with the preparation of the lists. Of direct benefit to the Arboretum from this project was the compilation of a card catalogue of nurserymen's offerings, through which we have actually received to date over 500 species and varieties of woody plants new to the Arboretum plantings, and have

located about 1000 more in various European nurseries which we shall attempt to acquire in the next few years.

Cytogenetic Laboratory. — Cytological analyses of X-ray effects have been completed during the past year, under the direction of Dr. Sax and his associates. These results have thrown some light on the effect of irradiation on both chromosome structure and gene mutation. The irradiation work is being continued, using heat, X-rays, and neutrons.

The irradiation of seeds and seedlings of ornamental shrubs has given interesting results. High dosage with X-rays produces gross chromosome aberrations which result in an immediate effect on plant growth. Dwarf and spreading types of cherries have been produced; and dwarf types of roses, lilacs, and apples were obtained. Second generations of these X-rayed plants should also show additional variation caused by gene mutation. This work is being continued on a larger scale, since we now have adequate nursery space for growing experimental plants.

Crossing work with ornamental shrubs and trees has been continued, with successful results in the cherries, lilacs, roses, and apples. Open pollinated seeds have also been planted, with the hope that natural hybrids will be obtained. Natural hybrids should occur frequently in the Arboretum, where single specimens of each of several species are growing in close proximity. Of the artificial hybrids already obtained, the more promising include a dwarf apple, crosses of several rose species with *Rosa rugosa,* a chlorophyll-deficient lilac hybrid, a weeping form of *Crataegus,* and a cross between *Forsythia intermedia* and *F. ovata.*

Wood anatomy. — To facilitate the work of Dr. Bailey, the entire Arboretum wood collection, about 5600 specimens, was transferred to the Biological Laboratory, and incorporated in the collections of the Bussey Institution and the Biological Laboratory. There new quarters have been provided and equipped to house the combined collections now approximating 22,000 specimens, supplemented by nearly 17,000 microscope slides.

During the year Dr. Bailey devoted much time to the study of the comparative structure of xylem in various plant families as a basis for a contemplated monograph on the cambium and its derivative tissues. Dr. Senn, a National Research Fellow, with the assistance of Mrs. Vestal, made a comprehensive study of the secondary xylem in the three subfamilies of the Leguminosae, these data now being correlated with the available cytological and taxonomic evidence. Mr. Barghoorn has under-

taken an extensive investigation of ray ontogeny in the xylem of both the gymnosperms and the angiosperms. During the year about 1200 photomicrographs, with accompanying lantern slides, were made in connection with the several research projects. All work accomplished by Dr. Bailey and his associates is closely coordinated with that of the staff members of the Division of Biology working in the same general field, and all available collections of anatomical and histological specimens, photographs, and microscope slides have been catalogued and rendered available for general use.

Plant Pathology. — The specialized herbarium in this unit serves a two-fold purpose, the general collections needed for constant reference and for the use of students, and the specialized collections as auxiliaries to or subjects for research. The herbarium has been steadily increased in both fields since the department was established in 1928. During the past year notably important research additions were made as the result of a collecting trip made by Dr. Faull in November and December, 1937 to Mexico and Guatemala.

The utilization of the extension services afforded by the laboratory continues to expand. Inquiries during the past season have been particularly numerous because of the prevalence of certain contagious plant diseases due to the unusually humid conditions. Among the diseases frequently reported, those appertaining to the Juniperus-Pomaceae rusts, crown rot of the dogwood and maples, tree wilts of the Verticillium types, and the coniferous rusts are being actively investigated. Work continues to be done on the Dutch elm disease, for the Arboretum is cooperating in the attempt to eradicate this threatening pest in America. Dr. Faull recently made an independent survey of the present situation in reference to this serious menace to our elms, visiting infected areas in New York, Connecticut and New Jersey. Maps and records of the Dutch Elm Disease Eradication offices were examined, Federal and State officials interviewed, and critical parts of the infected areas were inspected. Generally speaking, there has been no significant spread of the disease except in New York. There an area of about 900 square miles has been added by the detection of the disease in Dutchess County. In many places in New York and elsewhere the infected areas have been notably reduced as a result of the eradication and sanitation campaign now being actively prosecuted. There is still hope that complete eradication can be accomplished. Progress is being slowed up and success threatened by continuing the project as a W.P.A. activity. It is emphatically believed that the project should be turned over imme-

diately to the United States Department of Agriculture, to be supported from the regular appropriation of that unit.

The research activities have been largely centered on the crown rot of the dogwood, wilt diseases of the elm, maples and honey locusts, and the rusts of conifers. The cause of the crown rot has been determined and the research has been extended to various other broad-leaved trees. A new, highly virulent wilt disease of the honey locusts has been discovered and its cause demonstrated. Attention is now being given to control measures. In the coniferous rusts a monograph of the genus *Uredinopsis* has been completed and two publications are about to be issued. In addition, work has been completed on rusts of the genera *Pucciniastrum* and *Calyptospora*.

The Herbarium. — During the year 25,252 mounted specimens were distributed into the herbarium, bringing the total to 479,724 sheets of woody plants. Of these about 6300 came from India, Indo-China, and Malaysia, 2300 from China, 2700 from other parts of Asia, 5200 from North America, 2500 from Central and South America, 1800 from Europe and western Asia, and 1100 from Australia and Africa. The Japanese collections were greatly increased by the purchase of the Kenzo Shiota herbarium, 7331 sheets. Of these 2279 were added to the Arboretum herbarium, 4882 herbs and ferns transferred to the Gray Herbarium, 228 cellular cryptogams to the Farlow Herbarium, and 179 orchids to the Botanical Museum.

Within the year important new accessions, not yet mounted, approximately 48,000 numbers, often with numerous duplicates, have been received. Of these 3570 are from Hainan, Kwangsi, Kiangsi and Kwangtung, received from Lingnan University, each with four or five duplicates; 14,300 numbers from the Wang collection in Yunnan, through the Fan Memorial Institute of Biology, Peiping; 2778 numbers of Hainan plants from Sun Yatsen University, also with duplicates; 761 from the Lu Shan Arboretum; 612 Chinese plants from Handel-Mazzetti, collected by Licent; 1139 specimens from the Copenhagen Botanical Museum from the old Indian collections of Wallich, Voigt, and Didrichsen; 344 Helfer Indian plants from Prague; 385 numbers with numerous duplicates of Burma plants from Dr. Dickason of Judson College, Rangoon; 723 Sumatra and Philippine plants from the University of Michigan; 200 Bornean and Siam plants collected by Coolidge and Griswold; 857 Manchurian plants collected by Skvortzov; 2373 numbers of Asiatic plants from Leningrad, in exchange; 2500 numbers with ample duplicates, Brass New Guinea collections, second Archbold expedition

(Fly River region); 539 numbers from the Puget Sound region, collected by Thompson, with many duplicates; 350 Mexican plants collected by Hinton, 532 by Gentry, 1000 by Matuda, 486 by Lyonnet; 218 from Skutch, Costa Rica; 202 from Gentle, Honduras; 1290 Brazilian plants from Krukoff, 550 from Ducke; 2144 numbers from plants collected in the Arboretum; and 2922 specimens of Boraginaceae from various sources for identification. To the collection of photographic negatives of types and critical specimens 411 new negatives were added, bringing the total to 3723.

Loans to specialists in Europe, Asia and America amounted to 3866 specimens, while on our general exchange account 45,521 duplicates were distributed to institutions in Europe, Asia, Malaysia, Australia, North and South America. Supplementing this distribution of duplicates, 21,366 mounted specimens, representing herbaceous plants and ferns, were transmitted to the Gray Herbarium, 358 cryptogams were sent to the Farlow Herbarium, and 474 orchid specimens to the Botanical Museum. A general survey of the entire exchange situation was made, the net result being the partial elimination of institutions to which the Arboretum had sent much in the past and received little in return, and the development of important new exchanges with institutions with which we had formerly little or no exchange relations. The net result has been excellent in that we are to receive many important historical collections on an exchange basis, material that could be secured in no other way.

The number of visitors consulting the herbarium increased considerably, including not only botanists from various American institutions, but also individuals from the Netherlands, Germany, Japan, New Zealand, and China. Miss Luetta Chen, a graduate student at Oberl n College, spent about two months working in the herbarium and library on her thesis during the winter. Office and herbarium space has been provided for Dr. Lawrence Ames of the United States Department of Agriculture throughout the year who continues his studies at the Arboretum on *Berberis* species in relation to rust resistance.

During the year the important Merrill-Walker Bibliography of Eastern Asiatic Botany was issued, a quarto volume of 719 pages. In association with Dr. Perry much work has been accomplished on the Old World *Eugenia* problem, several papers published, and others nearing completion. In association with Miss Freeman, the major part of the work on a revision of *Microtropis* has been completed. Prof. Rehder has concluded his study of the ligneous plants described from Eastern Asia by Léveillé, started in 1929 and involving the critical study of about

1200 species and varieties; he has devoted much time to the identification of plants cultivated in the Arboretum, and the current collections of Chinese plants as received. Dr. Johnston continues his studies on South American plants and on the Boraginaceae. Dr. Kobuski has continued his *Eurya* investigations. Dr. Allen has published a synopsis of the Chinese species of *Litsea, Neolitsea* and *Actinodaphne,* and is continuing her studies of Chinese Lauraceae. Dr. Raup has published the results of the Black Rock Forest studies based on his summer's work there in 1937. Dr. Croizat has published a number of papers on the Euphorbiaceae and plans to continue his studies. Dr. Jones has prosecuted work on the flora of the Puget Sound region and has initiated work on a revision of the American species of *Sorbus.*

In further development of cooperative botanical exploration for the benefit of the Arboretum, grants were made to the Fan Memorial Institute of Biology, Peiping; Lingnan University and Sun Yatsen University, Canton; Judson College, Rangoon, Burma; Royal Botanic Garden, Calcutta, and the Madras Museum, Madras, India; the Botanic Gardens, Singapore; Botanic Gardens, Buitenzorg, Java; the New York Botanical Garden for work in Colombia; the Missouri Botanic Garden for work in Panama; the University of Michigan for work in the Philippines; the Atkins Institution for work in Cuba; the University of Minnesota for Dr. Abbe's projected trip to the unexplored eastern shore of Hudson's Bay; the Botanical Museum for work in Louisiana and Mississippi by Mr. Correll; to K. Uno for field work in Japan; to Dr. A. Pételot for field work in Indo-China; to the Richard Archbold Expedition for the exploration of New Guinea; and to J. W. Thompson of Seattle for field work in British Columbia.

The making of these modest grants from the unrestricted gift funds of the Arboretum has proved to be unquestionably the most economical and at the same time the most efficient method of increasing its essential reference collections. Combined with the botanical field work arrangements have been completed for securing extensive collections of seeds, particularly from those regions from which we may expect additions to the list of hardy species that may thrive in the New England climate. The accessions from this source have been important in the past few years but give every promise of becoming infinitely more important in the immediate future. Such collections supply us with not only the important study set for our own herbarium, but also ample duplicates for exchange purposes, placing the institution in a most favorable position for negotiating important new exchanges.

An important herbarium innovation initiated during the year has

been the breaking down of the large and cumbersome genera by geographic areas, stressing first the Old World representatives. For this purpose new jute genus covers in eleven different colors have been selected. The task was approximately one-third completed before the end of the year. The net result is a great saving of time when one is making identifications by comparison. Associated with this work the task of inserting clipped or typed descriptions and critical notes has been extended, and about 20,000 items have been inserted during the year. The card catalogue index to new genera, species, varieties, and illustrations of ligneous plants now contains 117,387 entries, 3774 having been added during the year. Preliminary work has been done on the proposition to clip and paste all the entries in Index Kewensis and its nine supplements in a single alphabetic sequence in loose-leaf ledger form. Once completed this will be a vast improvement and one that will greatly increase the efficiency of our staff.

The Library. — At the end of the fiscal year the library contained 43,557 bound volumes, 12,303 pamphlets, 18,178 photographs, 200 unbound volumes, 2500 slides, and several thousand nursery catalogues. Additions during the year include 585 volumes, 300 pamphlets, and 369 photographs, including 173 of lilacs, the gift of Mrs. Susan D. McKelvey for whom they were made for publication in her book, The Lilac. A total of 10,231 cards were distributed in the various indices, 1510 slips were filed in preparation for a supplement to the author and subject catalogues of the library, making the number now available for publication 26,209. Two hundred and eighty volumes were bound. The number of inter-library loans increased. Fifteen new periodicals have been added to our subscription and exchange lists. To facilitate the work of our staff members in the Biological Laboratories, 309 publications on wood anatomy and morphology were temporarily deposited in these Laboratories. A new stack of five double sections was acquired and installed in the upper library to relieve the congestion in the American periodical room, and a new map case was designed and constructed to accommodate the map collection.

The Atkins Institution of the Arnold Arboretum, Soledad, Cienfuegos, Cuba. — During the year much thinning has been done where there were too many specimens of a single species. Poorly located and sickly specimens have been removed where the same species was represented by better specimens in suitable locations. The extensive native wood lot is now much easier to control as undesirable vines and spiny

shrubs have been largely eliminated. Several hundred young timber trees have been received from the Bureau of Mines of the Cuban government, and planted in the native wood lot. All the native orchids have been assembled in one particular area in this section.

The new cactus garden is now well established. The large number of cacti and other succulents now being received has made it necessary to provide extra space for these plants. A high, sloping, partly rocky area of approximately 12 acres has been selected for this succulent garden, and is being prepared for planting. This should provide ample space for immediately contemplated and future plantings. The old garden has now been fully planted with young palms and the old storm-wrecked trees in this area are being gradually removed as conditions warrant. A collection of fruit-bearing trees has been established in the Harvard House grounds and this will be gradually extended, thus supplying the material essential to a comprehensive breeding project. A small grant from Arboretum funds enables the institution to subsidize botanical and horticultural explorations in Cuba.

The opening of the new road direct from Havana to Cienfuegos via Soledad has greatly increased the number of visitors to the Garden and a number of official visits have been made by the Governor of the Province of Santa Clara and many other persons to whom we are very glad to demonstrate what the Institution has accomplished in bringing new plants into cultivation in Cuba. In recognition of their repeated visits and the many gifts which they have made, not only of living material but of additions to the herbarium, on nomination by the Custodian, the Corporation appointed the following individuals to the newly established position of Collaborators of the Atkins Institution of the Arnold Arboretum. These new Collaborators, all distinguished botanists or individuals interested in forestry and sylviculture, are:

Dr. Juan T. Roig y Mesa
Brother Leon (Joseph Sylvestre Sauget y Barbier)
Dr. Gonzalo Martinez Fortun y Foyo
Dr. Julián Acuna y Galé
Dr. Alberto J. Fors y Reyes
Dr. Jorge Dechapelle
Dr. José Perez Carabia

The interests of these gentlemen has caused them frequently to spend a considerable amount of time at Harvard House so that the question of space has become acute. Thanks largely to the generosity of Mrs. Atkins, an annex is being built which will relieve this situation and make it possible to offer hospitality to visiting scientists from other universities.

Professor James A. Needham of Cornell spent nearly two months studying the metamorphosis of the Cuban dragonflies in the ponds in the Garden and was delighted with the results of his trip. Aside from this the Harvard College Fellowships for work at Soledad were held by Charles William Heimsch and Elso Sterrenberg Barghoorn. Doctor Harold E. Senn of the University of Virginia, holding a National Research Council Fellowship at Harvard University, also spent some months at the Garden preparing cytological material of flowers of many species of Acacieae. Doctor David E. Davis went to Soledad early last spring, aided by an anonymous friend of the Garden, to continue his studies of the breeding habits of the Ani, *Crotophaga,* and is still down there. Doctor Barbour visited the Garden as usual in February, and Doctor Merrill in March.

Up to the end of 1937 approximately 700 species were added to the living collections, these being received by gift and in exchange from a great variety of sources from the tropical and subtropical regions of both hemispheres. The planting list at the end of the year shows approximately 2750 species and varieties actually in cultivation at Soledad.

Publications. — The usual issues of the Journal and the Bulletin of Popular Information were prepared and regularly issued. Again as usual, a number of technical, semitechnical, and popular articles written by staff members were published in standard serials. The Merrill-Walker Bibliography of Eastern Asiatic Botany mentioned in the last annual report, was issued in May 1938. It is the most extensive publication issued during the year, comprising 719 quarto pages. Second in importance is Mrs. Susan Delano McKelvey's comprehensive treatment of the species of *Yucca* of the southwestern United States, part 1, a small quarto of 150 pages, beautifully printed on Worthy permanent paper, illustrated by 80 collotype plates. This was issued as a special publication of the Arnold Arboretum in a limited edition of 325 copies, publication being rendered possible by the author's generous offer to meet a part of the printing costs, particularly the plates. This appeared in June 1938.

Bibliography of the Published Writings of the Staff and Students July 1, 1937 — June 30, 1938

ALLEN, C. K. Studies in the Lauraceae. I. Chinese and Indo-Chinese species of Litsea, Neolitsea and Actinodaphne. Ann. Missouri Bot. Gard. **25**: 361–434. 1938.